

[13.05] Detecting the Yarkovsky effect with the use of radar astrometry

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The Yarkovsky effect is a non-gravitational acceleration stemming from anisotropic thermal emission of natural bodies in the solar system. It has been shown to be theoretically significant in the transport of material from the main asteroid belt and practically important in the navigation of artificial satellites; however, the effect has never been detected or measured on a natural body. In this work we show that the existence of precise radar astrometric observations of small near-Earth asteroids at multiple apparitions spanning periods on the order of ten years can allow the detection of the Yarkovsky effect. Since the observability of this phenomenon accumulates quadratically with time, the span between radar observations is a critical factor.

Although the currently available radar astrometry is insufficient to indicate the effect, we show that the next radar observing opportunities of several asteroids, in particular, the 2003 Earth encounter with 6489~Golevka and the 2015 encounters with 1566~Icarus and 1620~Geographos, could provide an unambiguous detection of the Yarkovsky effect. Moreover, we show that the Yarkovsky effect may play a very important role in the orbit determination of small, but still observable, bodies like 1998~KY₂₆. If carefully followed, this body may serve as a superb probe of the Yarkovsky effect in its next close approach to the Earth in June 2024. In light of these results we conclude that already in the next decade the orbit determination models of near-Earth asteroids will necessarily require that the Yarkovsky effect be modeled, and the relevant physical parameters be estimated. In particular, we predict that the surface thermal conductivity can be inferred from the dynamical behavior in some cases.

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